BELLCOMM, INC.

SUBJECT: Trip Report - ECS Tubing Joints, North American Aviation - SID Case 330

DATE: May 26, 1967

FROM: S. S. Fineblum

## ABSTRACT

As a means of acquiring a better understanding of the physical processes and problems involved in manufacturing tubing joints, I visited North American's Space Division at Downey. As a result, it was determined that the specific limitations were: the necessity for making a large number of joints in the spacecraft, the use of ordinary, somewhat dated, "B" nut technology, and the difficulty of heating the aluminum tubes to brazing temperatures within the confines of the CM.

It was learned that improvements had been suggested by NAA personnel some time ago. Now, however, such improvements are being incorporated or, at least, seriously considered.

The improvements being incorporated in the near future are an improved "B" nut and a shielded solder joint. Some of the improvements being considered are improved solder alloys; larger, improved solder joint sleeves; and a tube holder to prevent "B" nut installation torques from being transmitted to nearby solder joints. The incorporation of improved tube flaring for the "B" nut or the use of other, more modern, mechanical joints is required.

(NASA-CR-123350) TRIP REPORT - ECS TUBING JOINTS, NORTH AMERICAN AVIATION, SID (Bellcomm, Inc.) 5 p

N79-72614

Unclas
00/31 12138

FF No. 602 CR-123500 (NASA CR OR TMX OR AD NUMBER) (CATEGORY)

BELLCOMM, INC.

SUBJECT: Trip Report - ECS Tubing Joints, North American Aviation - SID Case 330

DATE: May 26, 1967

FROM: S. S. Fineblum

MEMORANDUM FOR FILE

Introduction

As a means of acquiring a better understanding of the physical processes and problems involved in manufacturing tubing joints, I visited North American's Space Division at Downey. This memo summarizes the tour, the discussions, the present physical limitations, and improvements presently considered.

The visit started with a brief discussion with B. Rosenberger of Apollo Manufacturing and Art Maier, who is in charge of all final assemblies for Apollo manufacturing. I assured them that I was not on an inspection trip: I wanted to learn what were the present methods and what were the limitations caused by the sequencing and scheduling, by the geometry of the installation and by other physical problems. Art Maier escorted me to the final assembly clean room, where I inspected the interior of CM 101 and 103 for general arrangement of tubing, saw a demonstration of soldering aluminum tubing and brazing steel tubing, and viewed X-rays of both satisfactory and unsatisfactory couplings.

I then visited the sub-assembly tubing department which is also a clean room and saw automatic welding of steel tubing. Still later, I saw the machinery for flaring tubes and for manufacturing "B" nut assemblies. I studied the machinery available for flaring and inspected some "B" nut assemblies. The most modern flaring tool in the department (an orbital ring type, Leonard Tube Master 3CP-HD) produces a smooth flare with high precision and small eccentricity. This tool, however, requires a minimum 3" straight length of tube in back of the flare for clearance and is not called out for CSM ECS assemblies. Instead, older flaring machines with split dies and generally poorer output are used. I also saw the salt bath for aluminum brazing. The salt bath was closed down because of the failure of a temperature control.

Later, in Art Maier's office, we discussed the improvements which are being considered in solder joints. The Engineering Development Laboratory is working on new solders. Longer solder joint sleeves with improved mechanical properties and armored joints are being considered. A tube holder has been proposed by Art Maier which would reduce the amount of net torque transmitted from the end where the "B" nut fitting is being assembled.

Afterwards I returned to Mr. Rosenberger's office and had a brief discussion with him in the presence of a purchasing supervisor, R. E. Jachura, and a representative from MSFC, Mr. Jack Friedman. Although these men seemed to be generally knowledgeable, they did not have any specific data to contribute.

I then visited Ed Copeland of Environmental Control System Engineering who explained the superiority of the Wiggins "B" nut. The "B" nuts manufactured by Wiggins are superior to the AN and MIL spec products in two important details:

1. The sleeve is shaped to get a better grip on the flare.

2. The threads are more precisely machined to assure a tighter, more permanent grip.

The purple or Wiggins "B" nut fittings are being introduced; unfortunately, the effectivity is CSM 107.

Mr. Ian Phillips showed me some soldered joints with enlarged sleeves and other improvements. These modified solder joints show much greater resistance to various mechanical stresses that seem to be the cause of some of the leaks in the soldered joints.

Impressions

In response to some of my questions about the possibilities of improving the joints, most of the people I spoke to expressed the feeling that, "Well, the joints aren't all that bad." They all seemed to be surprised when I quoted the number of leaks discovered at KSC.* None had ever heard of the General Electric Reliability Study of the tube joint problem.**

The technical capability, both in production and engineering, seemed to be on a sufficiently high level. There have been a large number of ideas, suggestions, and concepts for the improvement of tubing connections available for a long time in the various engineering and production organizations at North American. Only very recently are these improvements being actively considered for actual incorporation into the Apollo Program.

---

*There were a total of 28 on Spacecraft 009, 011 and 012.

**NASA, MSC letter to J. C. Cozad from ASPO (PR2-67), subject: "Contract NAS 9-150, Recommendations for Improvement in the Reliability of ECS Soldered Tubing Joints"

Improved flaring techniques are seriously needed. The flares for the CSM are, in my opinion, manufactured to ordinary aircraft standards with methods that seem to be about ten years old.

The decision to go to the improved Wiggins "B" nut is based on knowledge that is, at least, two years old. The larger soldered joint sleeves with increased area to improve the transmission of the various stresses through the joint promise to be a successful solution to that problem.

The dominant physical constraints of spacecraft production and installation of tubing require a large number of joints. This is necessary to permit installation in the clean room (after a significant degree of buildup) and removal and replacement at the Cape.

The aluminum tube assemblies have suffered mainly from two causes:

1. Relatively old "B" nut technology was used.

2. The high electrical and thermal conductivity of aluminum limits the heat that can be electrically generated for in-place brazing. Thus, low temperature (i.e., low strength) solder joints are presently required.

The first source of failure can be corrected now by improved "B" nuts and other mechanical fittings. The second source of joint failure can be remedied by improving and protecting the soldered joints.

Preliminary Recommendations

Mechanical Fittings - The best available techniques for mechanical fittings should be used to a much greater extent.

Soldered Fittings - Enlarged and improved sleeves for soldered joints should be incorporated. Efforts should be directed toward development of a technique to perform in-place brazing of aluminum tubes. Mechanical fittings should be considered.

2031-SSF-dly

S. S. Fineblum

BELLCOMM, INC.

Subject: Trip Report - ECS Tubing Joints, North American Aviation - SID

From: S. S. Fineblum

DISTRIBUTION LIST

NASA Headquarters

Messrs. L. E. Day/MAT
C. C. Gay/MAT
L. B. James/MA-A
T. A. Keegan/MA-2 ← COPY TO
C. H. King, Jr./MAT
R. V. Murad/MAT
A. F. Phillips/MAT
J. H. Turnock/MA-4
R. L. Wetherington/MAT
G. C. White, Jr./MAR
W. J. Willoughby/MAR

Manned Spacecraft Center

Messrs. R. Gillen/EC-3
E. L. Hays/EC
F. H. Samonski, Jr./EC-3

Bellcomm

Messrs. G. M. Anderson
C. Bidgood
A. P. Boysen, Jr.
D. R. Hagner
P. L. Havenstein
J. J. Hibbert
W. C. Hittinger
B. T. Howard
J. Z. Menard
I. D. Nehama
T. L. Powers
I. M. Ross
T. H. Thompson
G. B. Troussoff
R. L. Wagner
Department 2031
Department 1023
Central Files
Library